raised the question as to whether it was advisable to adopt what has been called the half-time course, that is to say, the system under which students attend the university or technical college classes during the winter and work in the shops or drawing offices during the summer. We may mention that this plan has been carried out in several towns, but as a rule employers are somewhat opposed to it. Sir William Preece declared—and it is a statement which cannot be too often made—that it is at the top and not at the bottom that we require radical changes in our technical education for engineers.

On Tuesday, September 16, a number of general papers were dealt with. The first paper, by Mr. W. H. Booth, treated of the smokeless combustion of bituminous fuel, and the author contended that as a rule boiler furnaces were badly designed in respect of the prevention of smoke. Furnaces must be arranged in such a way that all the gaseous products of the furnace are swept together with the admitted air, and are not cooled down until sufficiently burnt to admit of their being used for heating purposes; and he was of opinion that there was nothing in smoke prevention to justify the assertion that it was economically impossible. Mr. J. S. Raworth, in connection with this subject, described a system for the prevention of smoke known as the "Wilson smokeless process." A small quantity of nitrate of soda in solution is injected into the furnace with sufficient air to give perfect combustion, the cost being about 3*d*. to 4*d*. per ton of coal burnt; this system has been installed in a tobacco factory in Belfast, smoke has been abolished, and the output and efficiency of the boilers improved.

Prof. G. Forbes then gave an interesting account of his experiences in the late South African war with the infantry range-finder, which he described at the Glasgow meeting last September. Both officers and men who had served at the front were unanimous in their opinion that the great want which had so often nullified the strategy of our leaders and endurance of our men was a quick, handy, trustworthy one-man range-finder. In actual service this range-finder had proved that its accuracy was all that could be desired, and it was much quicker in action than the mekometer. During a trek of 300 miles in eleven days, he had been constantly called upon to give distances, and it never took longer than one minute to dismount from his horse, set up the range-finder and give the first range, other ranges being given in a few seconds. He was in action for two days, and was able to give the ranges quickly and accurately without any unnecessary exposure. With his own eyesight, which was not particularly good, he was able to get an accuracy of 2 per cent. in 3000 yards, but many of the men had been able to get a very much greater degree of accuracy than this.

Several other short communications were read, but we have not space to deal with them. T. H. B.

SCIENCE AND LITERATURE.[1]

ON what subject ought one to speak at the beginning of the session of a College of Science which is also a School of Applied Science, speaking, not only to one's colleagues, but to new and old students who differ from one another in character, training, social position and attainments more than the students of any other college probably in the world? This college has three functions. It gives the highest possible instruction in mathematics and natural philosophy and in all the natural sciences. It gives technical instruction to mining, metallurgical and mechanical engineers. It gives pedagogic training to teachers of all subjects taught at the college. The presence of Sir Arthur Rücker, Principal of London University, reminds me of a fourth function which has recently been added—namely, the preparation of students to pass university examinations.

I am strongly of opinion that every engineer—that is, every man whose business it is to apply any of the physical sciences—ought to have a more or less thorough training as a mechanical and electrical engineer. In the address which I had the honour to deliver three weeks ago as president of the Engineering Section of the British Association, I tried to show that only a very exceptional student can obtain such training unless he spends much time in mechanical or electrical engineering laboratories such as I there described. For many years, from long before I came to Kensington, the mechanics course here has been one in mechanical engineering as well as in mechanical philosophy. My anxiety to own a laboratory has met with the utmost sympathy from the higher authorities and the council of the college. I may say that we are all as anxious that students should work with electric generators and motors and other electric-power plant as with steam and gas engines, with water turbines and pumps. I know that some of you blame me because I can give none of this necessary instruction, and sometimes, perhaps, I blame others for not affording me facilities. The curriculum at this college was arranged a great many years ago, when people aimed only at the training of the exceptionally clever student, and, indeed, before any electrical appliance was used by miners or metallurgists; before the time when a mine became filled with mechanical contrivances. Every mining or metallurgical or other technical school now established in any part of the world gives this sort of training to the students which we are unable to give. The authorities of this College are in sympathy with you and with me, and would help us to this necessary laboratory work and greater space and other facilities for instruction in my division if they possibly could. Parenthetically, I may observe that, in so far as applied mechanics and engineering theory are concerned, the courses of study here will enable any willing student to obtain the highest engineering degree of the University of London.

Some of you are extremely well read in scientific text-books, having passed most severe examinations in pure and applied science. And not mere text-books, but real scientific books have been studied by many of you; for I know that some of you have dipped into Larmor's book on the ether, and have read Thomson and Tait and Maxwell and Rayleigh. Not only have you this wonderful knowledge in science, but you have been earning your own living and you have developed an instinct for taking advantage of chances, of fending for yourselves, of making other people do what you ask, that is perfectly marvellous. Some of you remind me of great fir-trees that I saw in Norway this summer, spreading their roots over a rocky soil, gaining sustenance where no other kind of tree could exist. One power more developed than another is that of passing examinations. Nobody who is without the experience of an examiner of candidates from the evening science classes can comprehend your power of getting marks from a careless examiner for answers to questions on subjects about which your knowledge is limited. There is hardly any town in the British Islands from which our scholars—I suppose that quite a hundred scholars are here—have not come, each picked from many hundreds or thousands, each the recipient of great honour and a valuable scholarship, and your townspeople and your old companions are keeping their eyes on you, wondering whether or not it is a great man of the future that has been sent up to us. And now for the other side. You know much of what has been done, but have you the power to discover, to add to the world's knowledge? Your knowledge has been derived from books and lectures; you have now to learn that a week in the laboratory, during which you seem to crawl, during which for examination purposes you do less than in reading ten lines of a text-book, is really of more value to your scientific education than a month's hard reading. This is almost unbelievable to you who are such adepts in passing examinations; yet it is quite true. Lectures and lessons have spoon-fed you until now; lectures and lessons will in future teach you to feed yourselves.

Again, many of you think it is not only a waste of time, but a positive sin, to read novels and poetry and general literature, to cultivate in any way the imagination, to take an interest in painting or sculpture or music. You have yet to learn that although parrots and other imitative animals can get on without imagination, there is no such thing in existence as an unimaginative scientific man. That you have some imagination and individuality is evidenced by your differentiation from all other students of science classes; but have you these well developed, and have you those other qualities which are absolutely necessary for the success of a scientific worker? Imagination is far and away the most important; but there are also judgment and common sense, and the love of truth and the power of self-sacrifice, which seem always to accompany the pursuit of science. Are you fond of reading? Do you know how to use books? Can you explain with decent sketches what you observe and know? Mere learning is a poor thing, but fondness for reading leads to the greatest possible development of all one's intellectual and emotional faculties. Fondness for reading will come to you if your companions are fond of reading. English and English subjects are badly taught in schools; hardly anybody anywhere seems able to teach them; one's own reading and discussion with friends are far better for one's education than any course of lectures. However limited your past education may have been, whatever defects some hypercritical learned man may see in the school system under which you have been brought up, starting from your present conditions, if you are fond of reading and have common sense, there is nothing to prevent your becoming men of the finest kind of liberal education. But you must exert your common sense and try to distinguish clearly what is essential from what is unessential in education. English literature is equal to, if not greater than, any literature of any people that exists now or has ever been. The language of our great Empire is enough for any man who is not specially fond of language study. If you love to study foreign or dead languages, do so; but if you are not so inclined you will be acting foolishly to waste your time over them.

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[1] Abridged from the inaugural address delivered at the Royal College of Science (with which is incorporated the Royal School of Mines), London, by Prof. John Perry, M.E., D.Sc., LL.D., F.R.S., Professor of Mechanics and Mathematics, on October 2.

The average man cannot be much hurt intellectually by anything he does, but the higher intellect is, I think, easily hurt, and I know of several men who had genius, real genius, whose intellects have been permanently dwarfed by a six months' course of classics pursued with the base object—degrading to classics and to themselves—of becoming able to pass an examination. There are some kinds of moral degradation which are final; the holy of holies has been desecrated once for all. My language about this matter will not probably be understood by more than a few of my hearers, but if there is even one who understands, my message is very important. If such a one is here I would warn him that there are certain prices too large to pay for examination success. I object very much to those examination systems in which certain things are compulsory. Of course, we cannot get rid of all compulsory things. English and English subjects must be compulsory on English students. But I do say that the list of compulsory things should be made as small as possible. I am told that a knowledge of the German language must be made compulsory for chemists and biologists. I am sorry to think that this may be so. But inasmuch as the men who tell me this say that it is the case also for physicists and mathematicians and engineers, I venture to doubt the necessity for compulsion in any case whatsoever. I am perfectly certain that in these days of much publication of translations and abstracts of foreign scientific papers, no kind of physicist or engineer needs French or German or any foreign language so much that it is *imperative* on him to make a study of it. The men who insist on the study of a language other than English do not seem to know how difficult such a study is for some students. Time will not allow me to do it here, but I hope some time to have a chance of pricking this compulsory foreign language bubble which everybody is cherishing at the present time without really thinking about its intrinsic value. How often have I heard common men say that they abhor translations; that the style and real flavour of an author are only to be had in the original. I notice that such men read very little. I doubt if the average educated man ever does get that kind of appreciation of a foreign author which the author's educated countrymen get so easily. I have met all sorts of men in my life, and I have never seen reason to alter the opinion of my young days that a lover of reading can get immense satisfaction from a translation—whether it is from Greek or Latin, French or German, Spanish or Italian, Russian, Scandinavian or Hebrew; whether it is Omar Khayyum or the Rig Veda, the Talmud or the Koran, or the Bible. To the lover of English all literature is open. The man who insists on reading "the original" seems to me like a tethered cow, such as we see in Jersey; it crops the grass very closely, but surely it must sometimes sigh for a little more freedom and a more extensive range of grazing! If you had finished your course here I would say to you that we are all getting far too learned in natural science. We read far too many of the latest papers. Some of the greatest scientific workers of our times—men who are constantly advancing the boundaries of knowledge—read almost nothing of what other men do. I wish I had time to give you some interesting, and indeed absurd, examples of this. The average scientific man merely casts his eyes over the twenty or thirty scientific periodicals that every man buys every month; he does not even read that valuable periodical "Science Abstracts," or those abstracts of chemical papers published so voluminously, for he has no time. The men who read everything that is written in scientific journals, not merely in England and America, but also in Germany and France, seem to me to have no time to do anything else; they have no time for scientific work of their own. Indeed, they know so much that a simple investigation such as they might begin upon their own account seems insignificant to them and quite unworthy of the time that they would have to spend upon it. I ask only that in matters like this of foreign languages and so much reading of scientific papers you should really judge for yourselves. In these days you can recognise the manufactured men of science by their taking up a notion without thinking about it, by their inclination to follow a leader as a flock of sheep follows the bell-wether, a phenomenon studied by a famous philosopher named Sydney Ortheris.

When the Prince Consort tried to impress upon this nation those ideas of training in science and art which, if they had been attended to, would have kept us in the front of industrial progress, there was one of his ideas which took root, and which has given rise to the work of the Science and Art Department. I know the faults of the department as well as anybody, but all my life I have been pointing out its enormous services to the country. No other country in the world has anything to compare with it. When I think of our industrial supremacy before 1870, and how during thirty years some of us have been vainly warning a careless people that the combination of wisdom and knowledge which we call science, neglected in the education of all well-to-do people, would lead other nations to the capture of our industries; when I think of the utter failure of our higher educational authorities to recognise facts, I bless the Science and Art Department. For more than forty years, in towns remote from universities, it has been possible for the poorest apprentice or workman to get instruction in natural science. These science and art classes were open to the very poorest. Until lately there were no other classes open to rich, clever students. It is astonishing to me that men should be ignorant of the fact that it is the Science and Art Department which has so far saved our industries. I can speak with knowledge of the engineering industries. Of the many hundreds of thousands of pupils who have successfully passed our examinations, a very large proportion, by the combination of their scientific knowledge or scientific habits of thought with practical workshop knowledge and through their energy, became foremen and managers, and in many cases owners, of works. I need not dwell on the fact that every year since 1869 many Whitworth scholars have been sent out into the industrial world, and I affirm of my own knowledge that these men have become such captains of industry as no other country in the world has at its command.

If only our capitalists had even the most elementary technical training such as is suitable for capitalists, the men educated by the Science and Art Department would alone have enabled them to retain that industrial supremacy the loss of which is being bewailed day by day in the newspapers. Many of our best men are making bricks without straw. They discover, they invent, they project improvements. But if the owner of the works, the son or grandson of the creator of an industry, if all the directors of a company, with however scientific a manager, are quite ignorant of those natural science principles on which the industry is based, if they cannot distinguish between good and evil, there is nothing for the industry except to go upon lines that get more and more old-fashioned until the works stop through inanition. And yet I have heard of cases in which old science students, in spite of heart-breaking failures to interest their superiors, have by dogged persistence maintained works as paying concerns, in spite of competition from American and German and Swiss strategists of the best polytechnic training.

Many of the most successful students hide the source to which they owe their scientific training, because the science class fees are small; the classes are open to the poorest students, and in this country caste feeling so predominates that no man likes to have it thought that he comes of poor parents or that he ever attended a class to which poor students were admitted. If all the successful old Science and Art students comprehended how much harm is being done just now by their careful concealment of the fact that the Science and Art Department used to be, and in many places still is, the only agency through which a scientific training could be given in this country; if they knew of the development which has been going on for some years in the functions of this department; if they knew the importance to the country of a general recognition of the services of the department, they would, I am sure, refrain from hiding their enormous obligations to it. No Government department has had so much intelligent criticism, because the only people who know about it are its own students, and they have by it been brought up in an atmosphere of scientific criticism.

And here are you students—about half of you—the picked men of these science classes, caught in our net, the net that Huxley spoke of, selected from thousands of students who are themselves select, selected that we may train most of you to be leaders of scientific thought or great appliers of science, or great teachers of science! There is the idea that for the good of the country our net has caught in one of you the young man most likely to repay cultivation, and I cannot too often repeat that it is not for your sake that this is done. If one of you happens to be a potential Faraday, however poor he may be, and so far as I can see he is just as likely to be poor as to be rich, it is our duty to try to discover him and give him chances of development. We are supposed to give you enough money to live upon; we ask no fees from you; we set you as men whom the King delighteth to honour, side by side with the most promising fee-paying students—men from our public schools, men taught to admire what you have done in the past, encouraged to think you men of promise—and we ask you to develop those exceptional faculties which to you are your own, but which we believe to be national assets.

I will conclude this address by bringing another and much more important problem before your consideration. The matriculation examination of a teaching university has this meaning only—that it is inadvisable to admit men who are obviously unfit to benefit by the instruction given in the university. When in mediæval Europe all university lectures were given in the one universal language, Latin; when men from all nations came to hear the same lectures, it was evident that no man ought to be admitted who had not enough Latin to be able to comprehend the lectures. As present in Glasgow it is assumed that everybody has had the usual school training, and the only matriculation is in signing one's name in a book. Hitherto at this college men who have passed certain examinations in elementary natural science are thought to be fit and proper students, and of course you scholars who have all passed rather difficult examinations in natural science are admitted without question. I am glad to think that every student admitted to this college does always seem capable of benefiting by our instruction; but if you consider what our object is, the education of true scientific men, you will see that there is something much higher than is attempted elsewhere.

Merely to be able to benefit by the instruction, that is a small thing. Men who come here with valuable scholarships are expected, not merely to benefit, but to benefit in a very exceptional way. They are supposed to develop to the very utmost their obvious scientific ability. To test for this likelihood of development in even the roughest way is evidently difficult. Even to apply any test outside the old limits seems difficult, because of the peculiar circumstances under which you are selected for scholarships. In more than half your cases you are not aware beforehand that you have a chance of being selected. You joined science classes merely to obtain a kind of knowledge which would be useful in your daily work. Your prospects were those of a workshop with a slow rise to foremanship. Your spare time was meagre; it was stolen at enormous sacrifice from family duty and from those pursuits which make a man popular with his fellow workers; the study of language and literature was comparatively unimportant to you, and you were suddenly told that your scientific talents were such that you were selected for the higher life, the life of the seeker after truth; of the man of brains rather than muscle. In seven cases out of ten, it was quite impossible for you to prepare yourselves for any examination in language or literature in the two months before entering this college. I wish I saw clearly what ought to be done. You are valuable material, and if you come here without that training in your own language, that love of reading which leads to the power to use books and the knowledge of all subjects derivable from books, I am quite sure that you are greatly wasted. I have a solution of this problem, but I am not sure that it is the best solution, and therefore I leave the problem for you yourselves to consider.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

PARLIAMENT reassembled on Thursday, October 16, for the resumed debate on the Committee stage of the Education Bill. In moving a resolution to give Government business precedence of all other matters during the remainder of the session, the Prime Minister took the opportunity to point out that the main object of the autumn sitting was to pass the Education Bill. The Committee has since its reassembly been engaged upon Clause 8 of the Bill, which defines the powers and duties of local education authorities and the managers of schools. The part of the clause passed reads as follows:—"The local education authority shall maintain and keep efficient all public elementary schools within their area which are necessary, and have the control of all expenditure required for that purpose other than expenditure for which, under this Act, provision is to be made by the managers." As we go to press the subsections of this clause are under consideration.

AN appendix to the calendar for the session 1902–3 of the University College of North Wales provides a very complete account of the agricultural department, which has been much developed since its inauguration in 1888. In addition to the ordinary entrance scholarships and exhibitions open to all students entering the College, there are five scholarships for which students proposing to take the agricultural course may alone compete. The College offers a diploma in agriculture, and students may enter for the degree of bachelor of science, in the group of agriculture and rural economy, in connection with the University of Wales. In cooperation with five county councils, a complete scheme of "out-college" work in agriculture has been organised.

THE many good results which will eventually follow the reconstitution of the University of London are heralded by the new departures in the work of University College, London, all of them explained fully in the calendar for the session 1902–3. Complete university courses of study in the various faculties included in the work of the College have now been established. Among other developments are the institution of a full sessional, instead of a terminal, course in the psychological laboratory; the endowment of the department of pure mathematics by Mr. Astor; the reorganisation of the department of chemistry and the appointment of Prof. Collie to the chair of organic chemistry; the institution of a new matriculation examination for engineering students and the reorganisation of the curriculum preparatory for the diploma in engineering.

THE University of Birmingham *Engineering Magazine* (a well-edited little paper published by the University Engineering Society) contains in its October number an article on continental methods of training engineers, from the pen of Dr. D. K. Morris. The author considers that the chief differences in the courses of study are due to the high quality of the preliminary training and to the number of students. The latter enables special courses to be held; a student can in consequence take, in a subject not actually his own, a course which is specially suited to him, and has not to rest content with taking part of the general course for students of that subject. The electrical laboratories, it is said, have outdistanced those for civil and mechanical engineering, and a special feature in some of the technical high schools is a loan collection of the latest types of machinery provided by the leading manufacturers. Certainly a striking feature of technical education abroad seems to be the cooperation of the manufacturers and the teachers.

THE calendar of the Bristol University College for the session 1902–3 reveals the existence of very satisfactory cooperation between the college and the manufacturers and other employers of labour in the district. In addition to a college engineering scholarship competed for annually, many of the local engineering firms have recently consented to give entrance scholarships to their works. The students nominated will obtain the combined college and works' education for about 50*l.* a year, whereas the ordinary premium paid by non-collegiate students in works is in general 100*l.* annually. The college council has consented to allow any firm offering these concessions to send one deserving apprentice to the college to attend the day lectures at half fees. A large number of local civil engineers, manufacturing engineers and architects have expressed approval of the courses of instruction arranged for students entering upon any of the careers they respectively represent.